SYS Technologies (formerly Cubic Defense Systems, Inc.)

Digital Video for PCs

In the mid-1990s, more than 100 million people worldwide were connected to networks via personal computers. Content providers wanted to include high-speed video clips on their web pages, but bottlenecks in the network precluded this feature. Cubic Defense Systems (CDS) had been working on a way to improve video compression code (codec) and thereby improve both the speed and the cost of transmitting video images over the Internet. The company applied to the Advanced Technology Program (ATP) in 1994 and received an award in 1995 under the "Digital Video in Information Networks" focused program. In 1996, CDS's parent corporation created Cubic VideoComm to further develop the technology. The new company produced a codec that combined features of two competing compression techniques and achieved higher quality with a compression rate ten times that of other codecs.

Cubic VideoComm arranged tests of an automated security system with the New York City Transit Authority, which significantly reduced the need for on-site monitoring. By the end of the ATP-funded project, the company had also developed prototype versions of video e-mail, videoconferencing, and intranet-based distance learning; however, once developed as products, none of these proved successful in the marketplace. In 1999, Cubic VideoComm spun off cVideo, Inc. to develop more products and serve small businesses. One year later, a patent for the codec was granted.

In the wake of September 11, 2001, government and industry wanted to improve security systems quickly and significantly. Using experience gained from the New York subway tests, cVideo successfully marketed its security system to a wide variety of clients. By 2004, the company had installed its security systems in retail establishments, banks, academic and corporate campuses, utilities, office buildings, hotels, and government facilities. In mid-2004, the company projected a profit within a year. cVideo credits the ATP-funded project for launching the technology and enabling the subsequent products, which are now installed in over 10,000 facilities nationwide. Late in 2005, SYS Technologies acquired cVideo.

COMPOSITE PERFORMANCE SCORE
(based on a four star rating)
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Research and data for Status Report 95-04-0008 were collected during January – March 2005.

Market Drives Search for Video Compression

In 1995, the United States dominated the world market for information network design, equipment, and online interactive services. But networks had limited capacity to distribute video materials, despite growing demand for features such as online multimedia information services and live video conferencing. The cost of delivering video over networks was high, and interoperability was a problem because there were several video transmission protocols in use.The protocols required significant amounts of computational power, and their quality was low.

Although video compression had been a focus of research for decades, compressing digital video was new and problematic. A television-quality frame uses 27 megabytes per second, and most personal computers (PCs) did not have the bandwidth to handle that amount of data.

Cubic Defense Systems (CDS) needed to transmit training videos over a wide variety of bandwidths. To answer this need, one of its project teams demonstrated a video compression–decompression source code (codec) that achieved high compression ratios and picture quality. But CDS needed an expanded team to accelerate research in the fast-developing Internet environment. In addition, the company foresaw applications for digital video over local area networks, wide area networks, and the Internet.

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When the project team approached CDS's parent, Cubic Corporation, for financing to expand the team, the parent company agreed to share some of the cost if another donor could be found. Cubic could not finance the entire research and development phase. In 1994, CDS applied to ATP and won an award under the "Digital Video in Information Networks" focused program. The two-year ATP-funded project (later extended for six more months) began in 1995.

Company Looks for PC-Based Technology

In its proposal to ATP, CDS defined its objective to develop next-generation video compression technology that would enable the delivery of digital video over Internet protocol (IP) networks to PCs. There were, however, risks to achieving this goal. The computer industry had not settled on a standard technology for compression–decompression. In addition to choosing which technology to use as its baseline, the project faced other challenges:

- *Developing adaptive compression.* CDS wanted to send images over a fixed bandwidth but allow the end user to adjust the amount of compression. This had never been done.
- *Integrating with real-time protocol (RTP).* The industry-wide Internet Engineering Task Force was developing RTP when the project started. Traditional codec research focused on sending images over networks with a time delay to enhance picture quality. RTP would define a format for sending audio and video over the Internet without the delay and with a high-quality picture. CDS expected that its technology would use this protocol, but had not decided on the specific way to do this.
- *Synchronizing.* The project team wanted to synchronize audio and video with global clocks, following a synchronization protocol.

Project Pursues Quality of Transmission

CDS said it could demonstrate good-quality compressed video using PCs, at a favorable cost. The company proposed to compress color images and synchronize audio data to greater than 150:1, or about twice what similar products were achieving at the time. The codec would improve performance over networks by measuring the quality of the communication channels between end points. The technique would use packet-switching, in which messages are subdivided into packets, are transmitted individually, and are routed in a variety of ways to their destination and then recompiled into the original message. Packet-switching, which was integral to Internet technology, was a new research area for distributing video at that time. CDS also planned to subcontract to the Information Sciences Institute (ISI) at the University of Southern California to customize a protocol for using the codec over a variety of networks.

The team determined that maintaining the quality of video transmission over a network with various bandwidth was the most crucial element of the project. To achieve high quality, they began by working with vector quantization, a data compression technique used in the "lossy method" in which some data are lost during file compression and decompression, but not enough to render the file unusable. Within six months, however, the team discovered that vector quantization would not yield the speed and quality they needed. They instead began pursuing a technology using wavelets, which compress images by analyzing video

frequency and then encoding the frame. CDS wrote and tested algorithms and network management techniques that send high-quality images almost instantly, which overcame the problem of lost or misplaced data. CDS also developed a small downloadable compressor with a combination of encoding and decoding software that would constantly monitor the available network bandwidth to adjust the compression rate for transmission of each video frame. The video file would not have to be saved on the receiver's hard drive, but could be viewed directly from the network, maintaining the same quality throughout.

By using the new technique, the team achieved high-quality video compression. The technique also permitted tradeoffs among video size and quality, channel quality, and data rate. In April 1996, Cubic Corporation created Cubic VideoComm to further develop the ATP-funded technology. By December, the new company reported that the adaptive video codec was able to distribute high-quality video clips from web sites. The video codec was adaptable to both circuit-switched networks, in which a separate path is established for each connection, and packet-switched networks, in which a separate path is established for each packet of data transmitted.

Although the team had been successful with video compression, they were unable to achieve their goals of integrating with real-time protocol (RTP). After their main researcher for RTP left ISI, the team worked with a member of the RTP standards committee at the Lawrence Livermore Laboratory. Ultimately, RTP did not adopt the standard that the team was using, so they abandoned the protocol and looked for other ways of sending video over networks. Audio/video synchronization was achieved but, according to William Guetz, Cubic VideoComm's chief technical officer, the technology is still not perfectly synchronized. "We got it to 'pretty good' and left it at that."

Corporations, educational institutions, government, and the military began to express interest in Cubic VideoComm's technology. In 1997, Cubic VideoComm adapted its technology for live video over IP networks in a pilot program with the New York City subway system.

Company Shifts Product Strategy

Although at the project's outset CDS had envisioned desktop video conferencing as the most profitable application for its codec, the market for videoconferencing declined as the technology was developing. As a result, Cubic VideoComm shifted to research on tools for simple access by users and began to adapt the codec's algorithms for other applications.

The major advantage of the technology was its cost and ease of use. The project developed a system that required specialized hardware and software at the transmitting end, but only software at the receiving end. In 1997, web sites were still primarily text only, although some pages inserted a window for a computer graphic or still image. Video content was available, but a PC user first had to download a video file to a hard drive. Tom Grady, Cubic VideoComm's Vice President for Strategic Planning, wrote that the company intended to develop software that would stream video over the Web, decompress data, and display it directly without requiring storage at the client site.

As ATP funding ended, Cubic VideoComm's marketing arm was investigating various commercial applications for the technology: video e-mail, security systems, and intranet-based training. By 1998, Cubic VideoComm had developed the following:

- Web video streaming software
- cVideo-Mail, which attached a video clip message to e-mail
- cVideo-Live, which transported live video over data networks
- An intranet-based multimedia training system for PCs

There appeared to be both internal and external validation for the soundness of these products. The California Commerce Agency's Office of Strategic Technology gave the company $800,000 to further develop the technology. In 1999, Cubic Corporation spun off cVideo Technologies Inc. to design, produce, and market products, and in July 2000, cVideo was granted a patent for the codec. However, when neither the web streaming software nor cVideo-Mail sold well, the company re-examined its strategy.

As the company was testing products for intranet-based training, it began to turn its attention to the surveillance market, using a variation of cVideo-Live. Based on the successful tests of its pilot security program in the New York subway system, the company developed DVRX, a closed-circuit digital recording and transmission system expressly for security networks. DVRX accommodates up to 16 surveillance cameras; PCs connected to the system can monitor, pan, tilt, or zoom from remote locations. Users can store and archive all recordings on a hard drive and customize motion-detection sensitivity and recording schedules. cVideo's system eliminates the need to change videotapes, as well as the delay and cost of locating and shipping tapes to remote sites.

After the World Trade Center and the Pentagon were attacked on September 11, 2001, the demand for security systems burgeoned. cVideo altered the codec to provide security systems for a wide variety of institutions, from schools to convenience stores and sports arenas. In fall 2004, cVideo introduced cVideo Intelligence, or cVI, an automated process that reads changes in the video image and issues an instantaneous report to an authorized person on or off site. This feature eliminates the need to station a person in front of the monitor continuously. The system can detect size, movement, and range of movement and can differentiate between animals and objects, between animals and humans, and between different animals. cVideo has also introduced cPOSVideo, a point-of-sale security video system for small, medium, and large-scale retailers; cBankVideo, which provides an interface between cVideo's server and automated teller machines; cCampusVideo, which allows live surveillance from multiple locations in real-time; and cCentralStationVideo, which integrates with central station applications, saves video recordings, and displays alarm video automatically.

Market Grows Quickly

According to cVideo, the market for its technology grows as the company introduces customized products. cVideo's systems are installed at more than 10,000 sites, covering retail and convenience stores, banks, campuses, telephone companies, utility companies, corporate offices, hotels, government sites, sports arenas, and mass transit systems. The company has clients in North America, the Baltic States, New Zealand, Canada, Mexico, Australia, Venezuela, and Brazil. In July 2005, the U.S. Government Services Agency qualified cVideo products for Federal and state agencies, the Department of Defense, and other General Services Administration (GSA) clients.

Although cVideo has several competitors, the company maintains that its technology is more cost effective because of its distributed architecture, shared among servers on a network, which reduces costs by a factor of four. The patented codec gives the company a competitive edge over companies that do not own their source code. In 2004, the codec maintained the highest video compression rate in the industry.

Cubic Defense Systems proposed to compress color images and synchronize audio data to greater than 150:1, or about twice what similar products were achieving at the time.

cVideo has attracted about $5.5 million in venture capital from outside investors for collaboration in development. It entered into a strategic marketing arrangement with Cubic VideoComm, and has joint ventures in process. It is licensing the patent to original equipment manufacturers (companies that buy, customize, and resell computers). Since 2001, cVideo's products have been featured in a dozen articles in the trade press and mainstream media. The San Diego Police Department gave cVideo an award for enhancing security at the 2003 Super Bowl. In 2004, cVideo was a finalist in the San Diego American Electronics Association Awards, and Deloitte Touche named it the 9th fastest growing technology company in San Diego and 177th fastest growing in North America. Late in 2005, SYS Technologies paid $1.5 million to acquire cVideo in a friendly takeover and has integrated it into its Public Safety, Security, and Industrial Solutions Group.

cVideo and its predecessors invested more than $12 million in research and development, but the company credits ATP's funding for launching the technology. "We wouldn't have taken on that technology," said Vice President of Finance Patrick Luedke. The first product that resulted from the project is a small part of the company's product line, but all subsequent products

have been based on it. In fact, cVideo Inc. probably would not exist if ATP had not funded its research in video compression, said Al Tumini, formerly cVideo president and chief executive officer and now a consultant to SYS Technologies.

cVideo's systems are installed at more than 10,000 sites.

Computer networks have evolved extensively since the ATP-funded project began in 1995. At that time, networks consisted of servers and PCs. With the rapid evolution of computing power, sensors, the Internet, wireless communications, and related technologies came rapid production and consumer adoption of multimedia data. As of 2006, all manner of devices, large and small, are network-enabled. The computer industry is phasing in Internet Protocol Version 6 to accommodate the burgeoning market's need for connective devices. Surveillance end-users are demanding user-centric integrated surveillance systems that take a "fused" approach to user needs, that is, video, audio, and sensor data are retrieved, viewed and manipulated at a higher informational level.

Video surveillance is no longer accomplished through human observation of simple video sequences, but rather through intelligent video sequence analytics based on additional data (sensors data and real-time video object analysis, for example). As a result of the ATP investment, the technology now owned by SYS Technologies is strategically positioned to develop products for this nascent generation of video surveillance: intelligent integrated video surveillance, with feature-based search and retrieval of video sequences.

"Recent world events have created a significant demand for better communications and response. The most challenging task is getting critical information to decision makers in a timely manner. cVideo will assist SYS in providing capabilities and services designed specifically to address this need. Public safety and security personnel will use these solutions to increase information visibility, sharing and understanding in order to improve emergency management and response" said Nelson Faller, cVideo/SYS Vice President of Business Development and Sales.

Conclusion

The computer industry was looking for better technology to transmit video images over the Internet and intranets in the mid-1990s. Cubic Defense Systems (CDS) had developed a prototype method of compressing digital video data, but needed to accelerate the research to keep pace with developments in the industry. CDS applied for and received funding from ATP to improve the speed and cost of transmitting video to PCs connected via the Internet.

CDS's parent company formed a separate entity, Cubic VideoComm, in 1996 to further develop the video compression code (codec) technology. After switching to a wavelet technique for compression, by 1998 the new company had developed a unique patented technology that allowed transmission over video networks at high quality and speed. The result was an advanced codec achieving extremely high compression at high quality.

Cubic VideoComm developed and tested a surveillance application and spun off cVideo Inc. in 1999. cVideo subsequently developed a closed-circuit digital recording and transmission security system that incorporated both hardware and software and allowed customers to store, archive, and retrieve video records on the computer's hard drive rather than on tapes.

After September 11, 2001, security companies saw a dramatic increase in demand for their products and services. By 2004, cVideo had installed its systems in thousands of locations across the United States and was successfully pursuing international markets. Company officials say the market for their systems continues to grow, and the outlook for this technology is strong. At present, cVideo systems are installed at more than 10,000 sites. Late in 2005, cVideo was acquired by SYS Technologies for $1.5 million.

PROJECT HIGHLIGHTS
SYS Technologies (formerly Cubic Defense Systems, Inc.)

Project Title: Digital Video for PCs (Adaptive Video Codec for Information Networks)

Project: To develop next-generation video compression technology that will deliver digital video over Internet protocol networks to personal computers.

Duration: 9/25/1995 - 3/31/1998
ATP Number: 95-04-0008

Funding (in thousands):**

ATP Final Cost	$1,739	70.3%
Participant Final Cost	735	29.7%
Total	$2,474	

Accomplishments: With ATP funding, Cubic VideoComm and its spinoff cVideo accomplished the following:

- Developed a technique and product based on digital video compression for transmitting high-quality downloadable video images live over networks
- Achieved the industry's highest compression rate, 10 times more powerful than the industry standard
- Received an award from San Diego Police Department for enhancing security at the 2003 Super Bowl
- Received an award from Deloitte Touche in 2004 as the 9th fastest growing technology company in San Diego and the 177th in North America

The company received the following patent for technologies related to the ATP-funded project:

- "Continuously adaptive digital video compression system and method for a web streamer" (No. 6,091,777: filed May 26, 1998, granted July 18, 2000)

Commercialization Status: cVideo adapted video compression technology to commercial applications in video mail, video conferencing, and intranet instruction. It developed eight products:

- cVideo-Mail, which attached a live video clip to e-mail (cVideo-Mail is no longer on the market)
- cVideo-Live, which transports live video over data networks (cVideo-Live is no longer on the market)
- cVideo Intelligence, which tracks objects; filters nuisance video; distinguishes among human, vehicle, and other activity; tracks directionally; and configures data to send alerts of suspicious situations
- cAccessVideo, which links recorded video to access history and links live video to alarms
- cBankVideo, which provides an interface between cVideo's server and automated teller machines
- cCampusVideo, which allows live surveillance from multiple locations in real-time
- cCentralStationVideo, which integrates with central station applications, saves video recordings, and displays alarm video automatically
- cPOSVideo, which integrates digital video technology with point-of-sale (POS) systems and cash registers and matches POS transaction data with video

Outlook: Cubic Defense Systems (CDS) and its successor companies, Cubic VideoComm and cVideo, tried a variety of applications for their patented video compression technology. Although some applications were not successful, the security systems have sold very well in a growing market. With the commercial success of these systems, cVideo became a surveillance company. In late 2005, SYS Technologies acquired cVideo. The outlook for this technology is strong.

Composite Performance Score: * * * *

Focused Program: Digital Video in Information Networks, 1995

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** As of December 9, 1997, large single applicant firms are required to pay 60% of all ATP project costs. Prior to this date, single applicant firms, regardless of size, were required to pay indirect costs.

PROJECT HIGHLIGHTS
SYS Technologies (formerly Cubic Defense Systems, Inc.)

Publications:

- Patta, Gig. “Video Device Enables Schools to Monitor Their Campuses.” *San Diego Business Journal*, May 7, 2001.
- “cVideo Announces Initiative to Emphasize School Applications.” *Securitysolutions.com*, June 1, 2001.
- “School Safety First.” *Building Design & Construction*, July 1, 2001.
- “Site Reports.” *Access Control & Security Systems Integration*, January 1, 2003.
- “Super Bowl Gets Safer with cVideo Digital Surveillance.” *FreshNews.com*, January 15, 2003.
- “cVideo Inc.” *Business News*, March 1, 2003.
- “Company Integrates with POS Systems.” *National Petroleum News*, June 1, 2003.
- Ozer, Jan. “Streaming Video: A Welcome Reception.” *PC Magazine*, June 25, 2003.
- “Forward Thinking for a Changing World.” *Security Management*, August 1, 2003.
- “cVideo to be Recognized as Fast Growing Business.” *Security Systems News*, August 10, 2004.